

FAULT DIAGNOSIS

Kathy Abbott
NASA Langley Research Center

1999年12月31日 年 度 結 算 報 告 書 第 一 次 公 開 招 標 招 標 文 件

1. 招 標 人 名 稱 : 中 國 鐵 道 建 設 總 局 第 一 工 務 局
2. 招 標 人 地 址 : 中 國 鐵 道 建 設 總 局 第 一 工 務 局
3. 招 標 人 電 話 : 010-51835000
4. 招 標 人 傳 真 : 010-51835000
5. 招 標 人 網 址 : www.12306.cn

1. 招 標 人 名 稱 : 中 國 鐵 道 建 設 總 局 第 一 工 務 局
2. 招 標 人 地 址 : 中 國 鐵 道 建 設 總 局 第 一 工 務 局
3. 招 標 人 電 話 : 010-51835000
4. 招 標 人 傳 真 : 010-51835000
5. 招 標 人 網 址 : www.12306.cn

1. 招 標 人 名 稱 : 中 國 鐵 道 建 設 總 局 第 一 工 務 局
2. 招 標 人 地 址 : 中 國 鐵 道 建 設 總 局 第 一 工 務 局
3. 招 標 人 電 話 : 010-51835000
4. 招 標 人 傳 真 : 010-51835000
5. 招 標 人 網 址 : www.12306.cn

FAULT DIAGNOSIS

The objective of the research in this area of fault management is to develop and implement a decision aiding concept for diagnosing faults, especially faults which are difficult for pilots to identify, and to develop methods for presenting the diagnosis information to the flight crew in a timely and comprehensible manner.

The requirements for the diagnosis concept were identified by interviewing pilots, analyzing actual incident and accident cases, and examining psychology literature on how humans perform diagnosis. The diagnosis decision aiding concept developed based on those requirements takes abnormal sensor readings as input, as identified by a fault monitor. Based on these abnormal sensor readings, the diagnosis concept identifies the cause or source of the fault and all components affected by the fault. This concept was implemented for diagnosis of aircraft propulsion and hydraulic subsystems in a computer program called Draphys (Diagnostic Reasoning About Physical Systems).

Draphys is unique in two important ways. First, it uses models of both functional and physical relationships in the subsystems. Using both models enables the diagnostic reasoning to identify the fault propagation as the faulted system continues to operate, and to diagnose physical damage. Draphys also reasons about behavior of the faulted system over time, to eliminate possibilities as more information becomes available, and to update the system status as more components are affected by the fault.

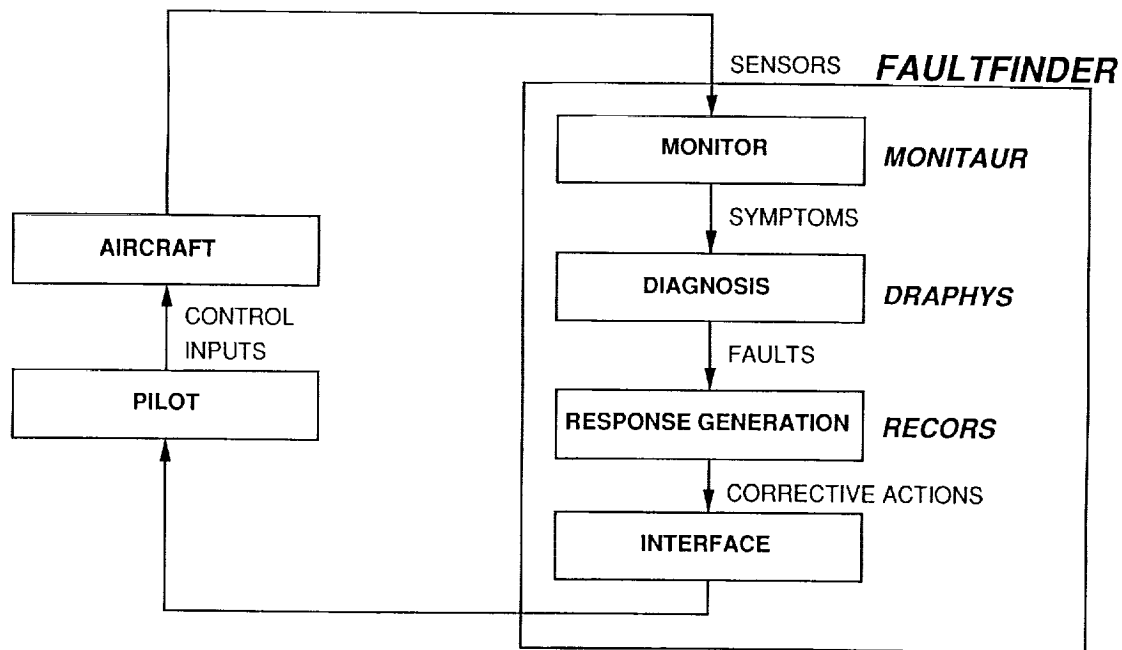
The crew interface research is examining display issues associated with presenting diagnosis information to the flight crew. One study examined issues for presenting system status information. One lesson learned from that study was that pilots found fault situations to be more complex if they involved multiple subsystems. Another was pilots could identify the faulted systems more quickly if the system status was presented in pictorial or text format. Another study is currently under way to examine pilot mental models of the aircraft subsystems and their use in diagnosis tasks.

Future research plans include piloted simulation evaluation of the diagnosis decision aiding concepts and crew interface issues.

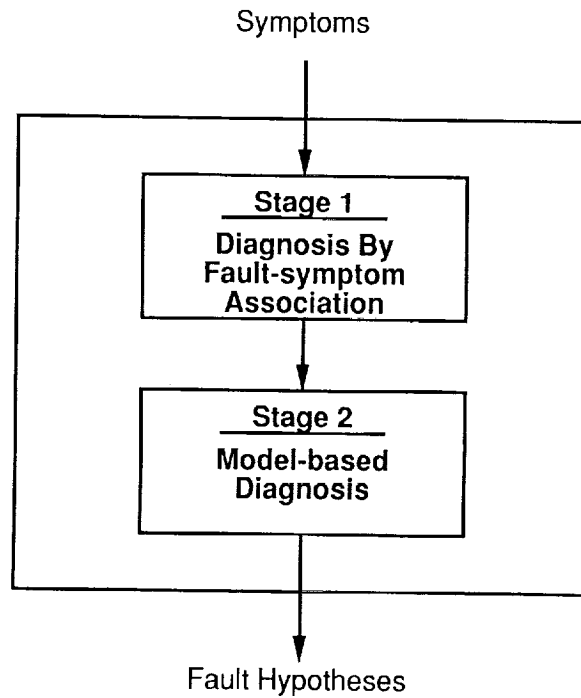
OUTLINE

- Decision Aiding Concepts for Diagnosis
- Crew Interfaces

SUBSYSTEM FAULT MANAGEMENT FUNCTIONAL DIAGRAM



SUBSYSTEM FAULT DIAGNOSIS



INFORMATION CONTAINED IN A FAULT HYPOTHESIS

- Cause Or Source Of The Problem
- Propagation Path
- System Status

UNIQUENESS OF DIAGNOSTIC REASONING

- Uses Models Of Both Functional And Physical Relationships
 - *Identify Fault Propagation*
 - *Diagnose Physical Damage*
- Reasons About Behavior Over Time
 - *Eliminate Possibilities*
 - *Update System Status*

DIAGNOSTIC REASONING CONCEPTS

Current Status

- Single Faults
- Propulsion and Hydraulic Subsystems
- Workstation Implementation
- Evaluated on Accident Cases

DIAGNOSTIC REASONING CONCEPTS

Future Directions

- Multiple Faults
- Electrical and Pneumatic Subsystems
- Real Time Implementation

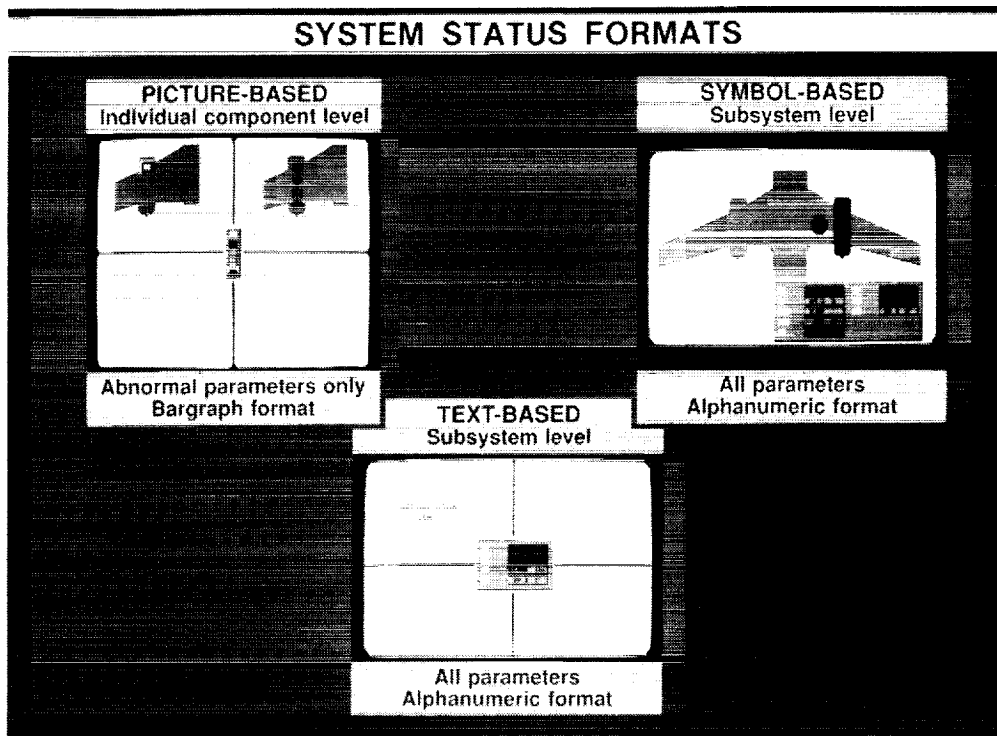
INITIAL CREW INTERFACE RESEARCH STUDY

Objective:

Provide display format guidelines for presenting system status information to improve situational awareness

Technical Issues Addressed:

- Display style (pictorial vs symbolic vs text)
- Hypothesis presentation style (composite vs multiple)
- Information density (all relevant vs out-of-tolerance only)



RESULTS

- Response time increased with display complexity
- Response time decreased with:
 - Pictorial and text display styles
 - Composite hypothesis presentation style
 - Out-of-tolerance only
- Errors of omission noted when multiple subsystems involved

PILOT DIAGNOSTIC REASONING STUDY

Objective:

Determine pilot mental models of aircraft subsystems and their use in diagnostic problem solving tasks

Technical Issues Addressed:

- Can Diagnosis Behavior Be Predicted Based On Knowledge Of Mental Models?
- Do Pilots Misdiagnose Because They Lack Knowledge Or Because They Apply Knowledge Improperly?

PILOT DIAGNOSTIC REASONING STUDY

Two Experiments

One Generic, One Application Specific

Results Of First Experiment

A Person's Fault Diagnosis Behavior Can Be Predicted Based On That Person's Mental Model

CREW INTERFACES FOR DIAGNOSIS

Future Directions

- Displaying Multiple Faults
- Displaying Fault Propagation Behavior
- When To Present Diagnostic Information